Managing a Multi-Institution Block Grant for Renewable Electricity Research

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Bruce has been engaged in higher education for 40 years as a teacher, curriculum specialist, and administrator. Over the past 24 years he served as Academic Dean at three colleges and as program director over several major grants. In his current position, Bruce is responsible for Energy related programs across Minnesota West campuses. At the state level, he administers implementation of 9 research projects in renewable energy as well as serving as Executive Director of the Minnesota State Energy Center of Excellence.

Bruce is a leader of collaborative efforts in the Minnesota system. He has been an initiator of many efforts of statewide influence. As a charter member of the Minnesota Energy Consortium, he has served on the leadership steering committee since the inception of the group. His leadership led to establishing the Energy Technical Specialist program, a multi-college program leading to industry positions in energy production in solar, wind, bio-fuels, fossil and nuclear fields.

Current focus areas of the Minnesota Energy Center include education for high school faculty to bring energy training into their classrooms, developing programming around emerging energy technologies, promotion of career awareness activities, and working on diversity challenges in the energy industry workforce.

Managing a Multi-Institution Block Grant for Renewable Electricity Research

1. Background

The Renewable Development Fund (RDF) was originally established in 1994 by the State of Minnesota. Funds are provided by Xcel Energy ratepayers in exchange for an allowance to store spent nuclear fuel from two nuclear generating plants in the state. The RDF funds are intended "to increase renewable energy market penetration, assist renewable energy projects and companies, and support emerging renewable energy technology" [1]. Funded projects can involve research and development of renewable electric technologies and can develop demonstration scale renewable electric delivery projects. RDF projects should "provide benefits to Minnesota citizens, businesses and Xcel Energy's electric ratepayers" and the results of all RDF projects must be made available to the public [2].

While the RDF program is managed by Xcel Energy and an Advisory Board, all activities and expenditures are subject to approval by the Minnesota Public Utilities Commission. Changes to the original statute provided Xcel Energy with the option of distributed "block grants" to Minnesota institutions of higher education. The institution would then be responsible for distributing the funds to multiple research projects which it would then manage. The latest Request for Proposals (RFP) was released in early 2013 for the program.

2. Minnesota State Block Grant Award

The Minnesota State system (formerly known as the Minnesota State Colleges and Universities) consists of 30 colleges, 7 universities, 8 Centers of Excellence, and over 400,000 students. It was determined early in 2013 that the system would submit a block grant proposal to the RDF program. The Minnesota Energy Center was selected as the fiscal and organizing agent within the system for this proposal. This mission of the Center is to provide industry validated technical training programs to prepare the future workforce of the energy industry. The Center serves as the education partner in the Minnesota Energy Consortium, working closely with industry leaders to evaluate workforce needs and align education programs to prepare a qualified and diverse workforce to provide safe and efficient energy to consumers.

To round out the proposal team two Co-Principal Investigators were sought, ideally from two system universities. Individuals with research grant experience and knowledge of the energy industry were sought. Their responsibilities included assisting with the narrative development, helping establish grant management guidelines, and ensuring that the proposal met sound research practices and procedures. The proposal was successful and awarded $5.5 million in 2016 for a three year grant period. This was later extended one year due to initial (non-related) legal delays at the state level and extended contract negotiations between the Xcel Energy and the Minnesota State system.

The next step was to issue a Request for Proposals to institutions within the Minnesota State system. It was decided to divide funding into two submission periods approximately six months

apart. Given a shortness of time it was important to get information out as quickly as possible to ensure a large number of quality submissions. In particular, there were several specific requirements placed on the possible research project due to the original statutory limitations.

> **Suggestion #1:** Disseminating the RFP by email and through webinar had limited effectiveness. Those campuses with a champion to encourage submissions had the best success. This person does not have to be a potential applicant but should be familiar enough with the topic to know who at the institution would be likely contributors. A champion should be identified early in the RFP process

Possible research topics were required to be related to renewable energy and had to relate to actual electricity production. Technologies such as wind, hydroelectric, biomass and biofuels used to make electricity, and solar photovoltaics fell into this category. Other technologies that fell into the statutory definition of renewable energy could also be proposed. These topics excluded several traditional areas for energy research. Topics focused on energy conservation or demand-side management were not eligible. Solar thermal research with a primary purpose of producing heat (e.g. for air or water heating) was also disallowed.

The proposed research methodology had to include standard items such as a quality control and validation process. Due to the nature and source of the funding extra emphasis was placed on potential impact to the State of Minnesota and active approaches to dissemination. Anticipated benefits were required in the areas of economic, environmental, intellectual property, benefits to Xcel Energy Electric Ratepayers, and benefits to research in the State of Minnesota.

3. Descriptions of Funded Projects

The Round 1 review resulted in five funded proposals and the Round 2 review resulted in four additional funded projects. As seen below the topics span several areas of renewable electricity generation. Grants were awarded to four year universities, two year community/technical colleges, and four/two year partnerships.

Round 1 Grants:

1. Universal and Scalable Smart Grid Power Converter (V. Winstead and S. Vietor)

This project is intended to incorporate concepts from “smart grid” interfacing and protocols, trans active energy (TE) and universal interconnect hardware into a single scalable configurable component. In other words, we intend to develop a device which is configurable (in firmware) and is capable of connecting electrically to a variety of power generation and energy storage devices (i.e. renewable energy generators, battery systems, ultracapacitor systems, hybrid vehicles, etc.) and provide a universal interface to the grid of the future. We can call this the Universal and Scalable Smart Grid Power Converter (USSGPC).

2. Improving Vertical Axis Wind Turbine Performance with Placement Strategies (P. Tebbe)

This project will examine understudied aspects of VAWTs with the goal of improving their implementation and performance. Aerodynamic interference caused by terrain, surrounding structures, and other wind turbines can not only decrease efficiency but can also increase

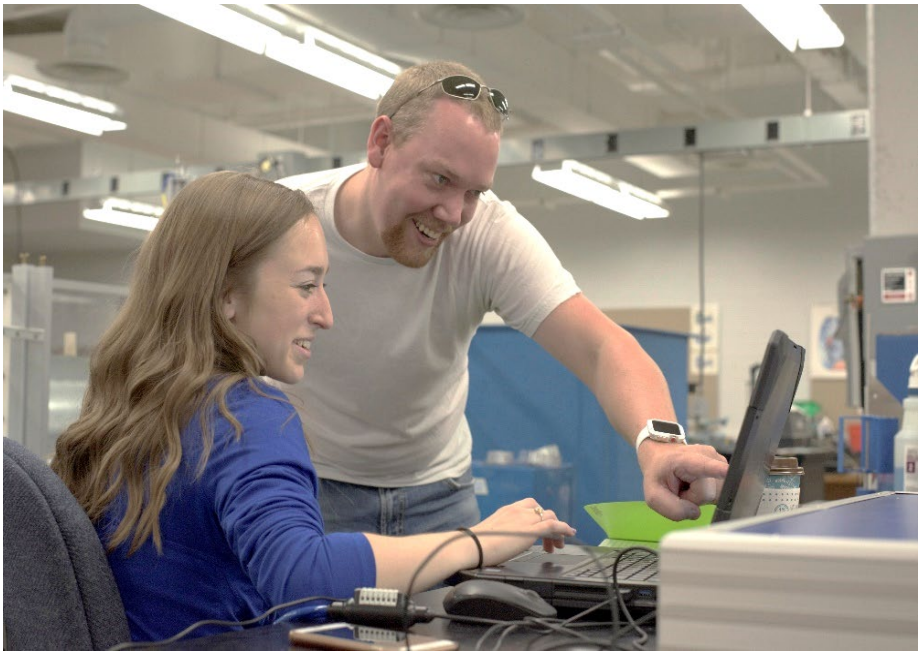

Figure 1: Undergraduate students working on data acquisition for wind turbine project.

efficiency. This research will address how placement affects the performance and efficiency of VAWTs through a combination of numerical and experimental efforts. The unique numerical approach of Leaky Rankine Bodies (LRB) with superposition will be explored as an accessible consumer tool. (Figure 1)

3. Microbial Power and Bioproduct Production from Using Food Waste (M. Julius)

This work involves anaerobic digestion of food waste streams for energy production and the utilization of other digester outputs for production of high value algal biomass research. The scientific “heart” of this research will be focused on minimizing waste stream outputs from the anaerobic digester while simultaneously creating an additional revenue stream. Variations organic inputs should illicit changes in anaerobic digester outputs. Researchers working with these variations will track and evaluate digester products as part of a life cycle analysis, quantifying greenhouse gasses, nitrogen, and phosphorus. A model to optimize waste stream reduction and biomass profits will be developed using information from the life cycle analysis data. (Figure 2)

4. No waste: fine-tuning digesters’ microbiome to maximize biogas production (R. Fink)

The principal scientific goal for this project is to produce a mature microbial community in a digester that is stable in terms of output and that can easily be manipulated through the organic waste input to maximize biogas production or, if needed, nutrient rich digestate for agribusiness.

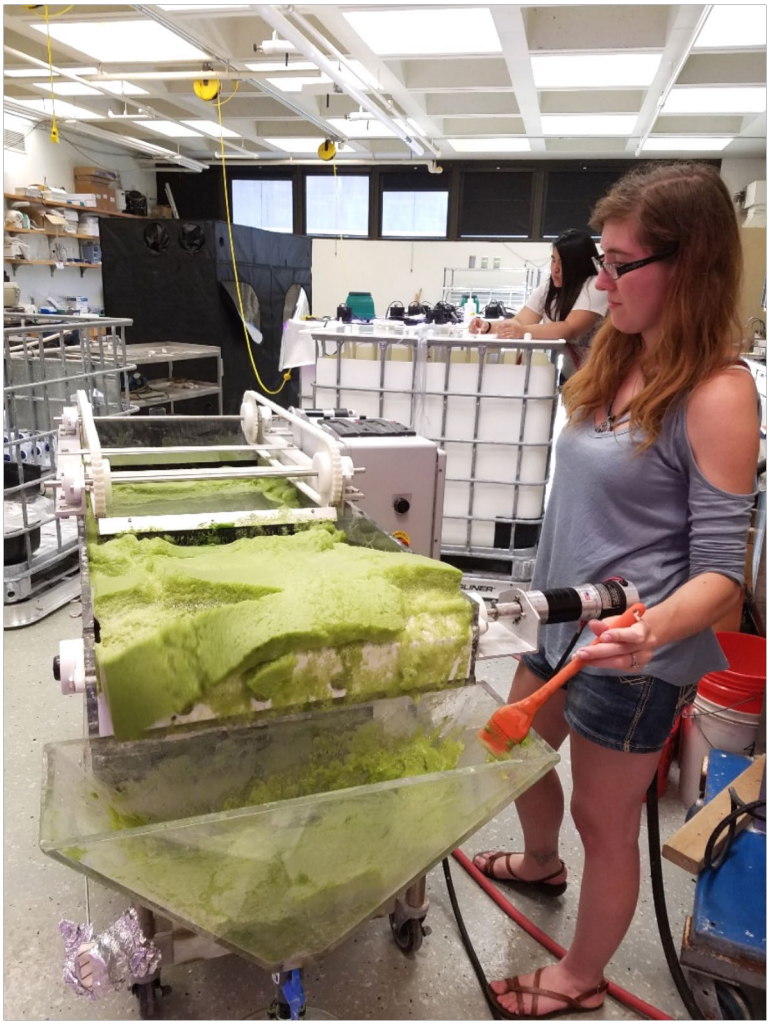

Figure 2: Student harvesting algae for microbial power project.

5. Investigate Strategies to minimize Negative impacts of soiling on PV Panel efficiency (S. Randall)

Conduct a research study to investigate strategies to minimize the negative impacts of soiling on photovoltaic (PV) panel efficiency and reduce the cost-per-kilowatt hour of electricity produced within the context of Minnesota's mid-latitude, mid-continental climate.

Round 2 Grants:

6. Axial Flux Generator Improvement (V. Winstead)

Develop a viable enhanced axial flux generator design with integrated ultracapacitor storage and Virtual Synchronous Generator (VSG) characteristic. Test and validate the design to ensure robust operability and demonstrate the enhanced capability for improved grid interoperability. Design and construct prototype axial flux generators with capability to emulate inertial

characteristics of large scale synchronous generators. Test and validate the prototype designs and demonstrate feasibility for higher output versions of the design.

7. Microwave Plasma Gasification System (J. Swanson)

Evaluate the technical feasibility, limitations and opportunities of microwave plasma gasification of solid biomass for small scale distributed electric power systems. Increase awareness of renewable electric energy technologies through timely information dissemination. Support renewable energy by generating a pipeline of educated and inspired engineering students seeking employment in this field.

8. An Intelligent wind/solar microgrid with wide bandgap multiport converter (J. Zeng)

Significantly increase security, reliability, efficiency, quality, and sustainability of electric power supply. This project will aim at microgrid systems with high reliability, high efficiency, compact structure, and low cost. Develop a cost effective high power density multiport converter. Improve power converter lifespan. Develop a multilayer power management strategy for microgrid systems.

9. Plug and Play Renewable Generation (S. Vietor)

To develop installation packages that can be installed, inspected and deployed in two days or less. To develop integrated solar/wind axial flux turbines using thin film/flexible solar cell technology providing dual source power.

A summary of student involvement across all of the projects is given in Table 1.

Table 1: Details on involvement with all projects.

Total number of personnel:	92
Number of faculty:	14
Number of students:	78
Number of male students:	59
Number of female students:	19
Number of minority students:	30

4. Challenges and Benefits That Were Encountered

The block grant included firsts for most parties. This was the first time Xcel Energy had awarded a block grant that would fund so many “smaller” projects. For the Minnesota State system managing a large grant across multiple institutions was a new experience. Several of the system institutions had little to no experience with funded research. This resulted in a number of delays and challenges that had to be overcome.

To manage the grant a team was assembled with representation from the Minnesota State system office, the Minnesota Energy Center, and system institutions. A specific need was incorporating

individuals with an energy background and significant grant and research experience to help guide the projects. The two Principal Investigators (PIs) who assisted with the original proposal to Xcel Energy were selected. However, these individuals were also the most likely to submit proposals for funding from the block grant. In fact, both PIs did submit proposals. Procedures were required that allowed for the largest and most diverse pool of proposals possible while managing any potential conflicts of interest.

Since the two PIs were from different universities and represented different technical fields the review and management of proposals was divided. The PIs were recused from not only their proposals, but all proposals from their institution. For those cases, the other PI served as the technical evaluator for review and eventual monitoring of the grants. Proposals from other institutions were reviewed by both PIs. This did not eliminate all concerns. When the grants were awarded one of the universities correctly flagged it as a potential conflict of interest. An administrative review was performed and additional oversight was put in place at the university level. All grant progress reports and budget reviews were required to be submitted to the Dean of the Graduate Studies and the Dean of Science, Engineering, and Technology for review.

> **Suggestion #2:** While the potential conflicts of interest ultimately proved not to be a major issue, resolution of them did cause a delay. Care should be taken to identify these early and begin any required internal evaluation, even before final grant decisions are made.

Since the Minnesota State system contains a diverse mix of institutions the block grant RFP went out to many interested parties who were relatively new to sponsored research. Rather than lower standards or expectations the grant management team made efforts to assist submitters. Advice from the PIs was provided in person and by email. In some cases, proposals for Round 1 were denied but with suggestions for corrections that could be made before Round 2. The aspects that proposers struggled with fell into several categories.

- The responsible conduct of research.
- Performing an appropriate experimental design (including control cases).
- What is and is not allowed in the budget.
- Correctly and completely addressing all RFP requirements.

It should also be noted that typically only the universities in the system have a grants or sponsored research office. The small institutions often do not have dedicated resources to help with pre- or post-award tasks.

> **Suggestion #3:** Larger institutions have years of experience with grant and budget management. Even though not all processes are transferable, a method of sharing best practices with institutions new to research is recommended.

The grant management team has discussed changes that would be needed if the block grant process, or something similar, was repeated. Many institutions have ideas that could be turned into strong research proposals. They have skilled staff and students who could undertake these projects. What they lack is training in the research process. Online and in-person workshops should be offered before the proposal deadline. This would allow experienced researchers and

grant professionals to offer advice and answer questions that may make the difference between a funded and unfunded proposal.

> **Suggestion #4:** If resources allow, a member of the grant management team should be assigned to work one-on-one with teams to write their proposals. To avoid conflicts this person should not be involved in the proposal review. Having more high-quality proposals only improves the overall effort and even those teams who are not awarded grants benefit from the process of improving their proposal.

Overall the major challenge has been a lack of time and personnel to handle all of the tasks. It has been difficult for the PIs to balance normal academic responsibilities, block grant management tasks such as visiting sites, and conducting their own research. With the funded grants now totaling nine the amount of paperwork necessary for fund disbursement and monitoring, reporting to Xcel Energy, and dissemination activities is sometimes beyond the capabilities of the team.

Students have reported several benefits from working on the projects. These include greater technical knowledge, but also the experience of working on a large project. In the case of one project, the students' desire to become an engineer and their belief that they can succeed in the program were increased by the experience [3].

5. Conclusions

While there have been challenges the block grant process has been very rewarding. Projects related to renewable energy are being conducted in a range of institutions. They are geographically diverse and represent different student populations. Where one university employs mostly post-doctoral and graduate students the other employs mostly upper level undergraduates. Conversely the community colleges are involving first and second year students who otherwise might not be exposed to research. To aid other teams in organizing a similar grant, four key suggestions have been presented.

Acknowledgments:

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References:

[1] Annual Report to the Minnesota State Legislature, February 15, 2016

[2] Renewable Development Fund Request For Proposals 4th Funding Cycle, Issued February 2013

[3] "Improving Vertical Axis Wind Turbine (VAWT) Performance", 2018 ASEE Annual Conference & Exposition, 2018.